CARBORUNDUM

Memorandum

To: S. C. DeSutter
A. H. Clark

Date: 7/13/89

From: B. R. Gardner

Copy to:

Subject: Use of Scheduler in Concrete Industry

Attached is a report from Ken Hover on applications of the Scheduler® Plant Stress Monitor to the concrete industry. The research to date looks promising. It's still too early to tell if there is a viable commercial application. Ken is enthused and anxious to continue the work.

BRG/lb

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Cornell University

HOLLISTER HALL, ITHACA, NY 14853-3501

July 10, 1989

Mr. Bronson Gardner
Product Technical Manager
Standard Oil Engineered Materials Co.
6180 Cochran Road
P.O. Box 39136
Solon, Ohio 44139

SENT VIA FAX

SUBJECT: Progress report and request for information

Dear Mr. Gardner:

You will be pleased that a great deal of work has been done with the "Scheduler" instrument over the past 6 weeks. Ms. Elizabeth Vokes has become proficient in the use of the instrument, and has used it on sample mortar slabs cast by Mr. Kevin Folliard. These two capable research assistants have developed data which suggests that the "Scheduler" can be an effective tool for concrete quality control in the field. I shall briefly report progress to date in the following letter, and close with a request for additional background information on the instrument itself.

1. Use of the Scheduler to Predict the Onset of Slab Cracking

Industry attention is currently focused on ambient conditions and predicted rates of evaporation from the surface of the concrete. Cracking is said to be likely when predicted (not measured) surface evaporation rates are in the range of 0.1 to 0.2 lbs of water/per square ft. of slab/per hour (lbs/sf/hr). Not only are the methods of predicting evaporation rate unreliable, but Cornell research in the last 3 years has called the threshold values of 0.1 to 0.2 lbs/sf/hr into question as well.

Against this background, one of our initial goals was to use the Scheduler to assess ambient conditions for use in an improved method of predicting rate of evaporation. (As you may recall, we were somewhat concerned initially that the instrument in its present configuration did not have the capability of assessing wind speed - this may not now be a problem.)

We have learned that the Scheduler permits us to bypass the independent steps of assessing external conditions and making theoretical predictions of surface evaporation and allows us to directly assess the effects that such conditions have on the concrete surface. To this end we have been evaluating the Plant Stress Index (PSI) as an indicator of

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concrete surface stress. Results to date suggest that a high Plant Stress Index is beneficial to fresh concrete, and that a low PSI (or even a temporarily decreasing PSI) is detrimental.

We have been conducting slab evaporation and cracking tests on mortar panels which are 24" wide, 36" long, and 3/4" deep. (This is the proposed standard specimen as defined by Paul Krali in San Diego, The FiberMesh Corp., Cornell, and under consideration by ASTM.) In two recent tests it was possible to correlate the onset of cracking in the concrete slab surface with a temporary drop in PSI.

Referring to Graphs #1-1 and #1-2, observe that in both tests #7 and #8, cracks appeared at the times shown, exactly at the time of the minor drop in PSI. Note that in Graph #1-3, the PSI monotonically increased for the duration of the experiment, i.e., no "drops" in Plant Stress Index; further, no cracks appeared during that experiment.

We are now in the process of trying to understand more about the Plant Stress Index, and we are statistically correlating it with other measurable factors.

2. Use of the Scheduler to Detect Evaporation Retardants.

Evaporation-retarding "curing compounds" are typically used on freshly-cast concrete surfaces. The perennial questions in field quality control are:

(1.) Has the generally colorless liquid been applied at all?

(2.) Has it been applied in sufficient quantity?

(3.) If it has been applied, is it effective?

Experiments 7-9 compared slabs which had received a coating of a construction-grade, evaporation retardant to slabs which had not. As can be seen in the graphs, the PSI is sensitive to the differences induced by this material. We are now turning our attention to assessing the meaning of the values obtained, and not just the differences between treated and untreated surfaces. We can see a clear difference, and in control specimens it is easy to distinguish treated mortar from untreated mortar, but we do not know how much difference is significant.

3. Field Trials

Having learned enough to be able to pose some good questions, we are looking for a full-scale construction operation to monitor with the Scheduler. We will keep you advised.

4. Request for Information

Given the high probability that Plant Stress Index is key to both agricultural and construction applications, we would like to know how the Scheduler computes this characteristic parameter. (The manual describes the PSI as being "proprietary.") Until we know more about it, we are forced to re-invent it by correlation to other factors such as crop temperature, VPD, etc. In a few more weeks we will have an approximation to it based on a regression approach, but I do not think that this is an efficient use of our time. Any help that you can provide will speed our search for a rational correlation of PSI to concrete behavior.

Sincerely,

Kenneth C. Hover, P.E., Ph.D.
Associate Professor of Structural Engineering

KCH/msw

encl.

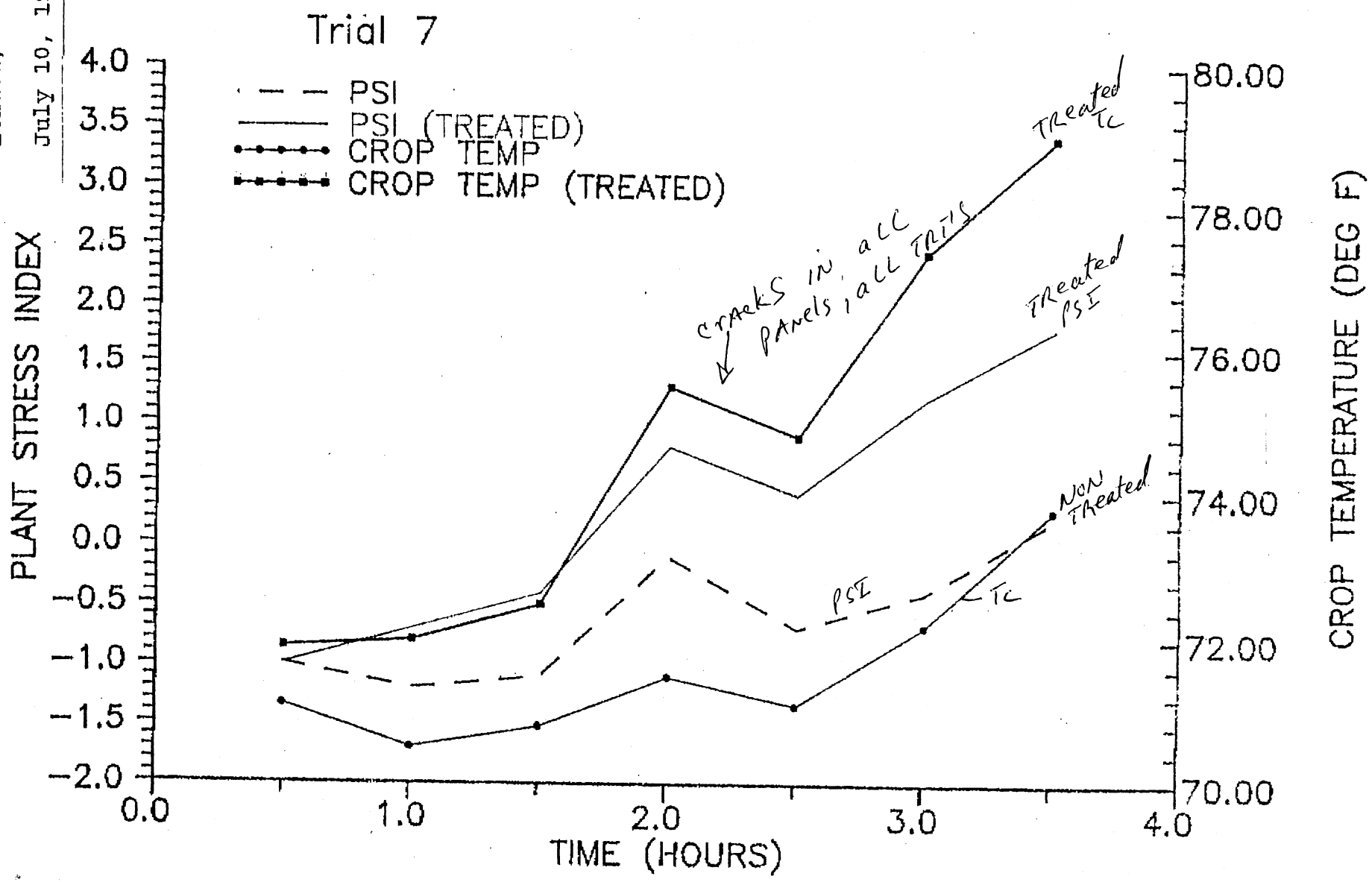
cc: E. Vokes
K. Folliard

#1

Preliminary Test Results
Concrete Materials
Research Program
Cornell University
Ithaca, New York

July 10, 1989

PLANT STRESS INDEX VS. CROP TEMPERATURE



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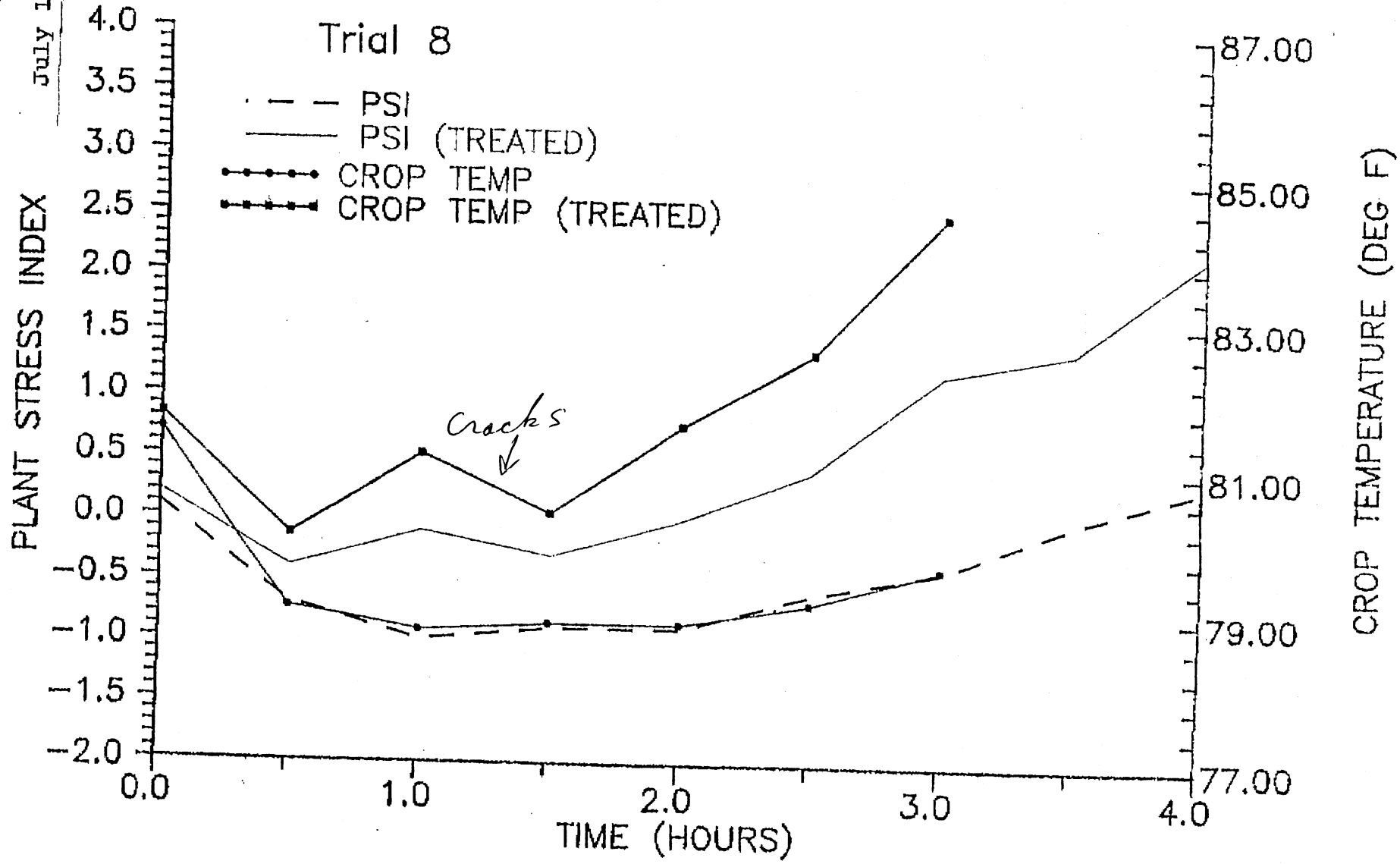

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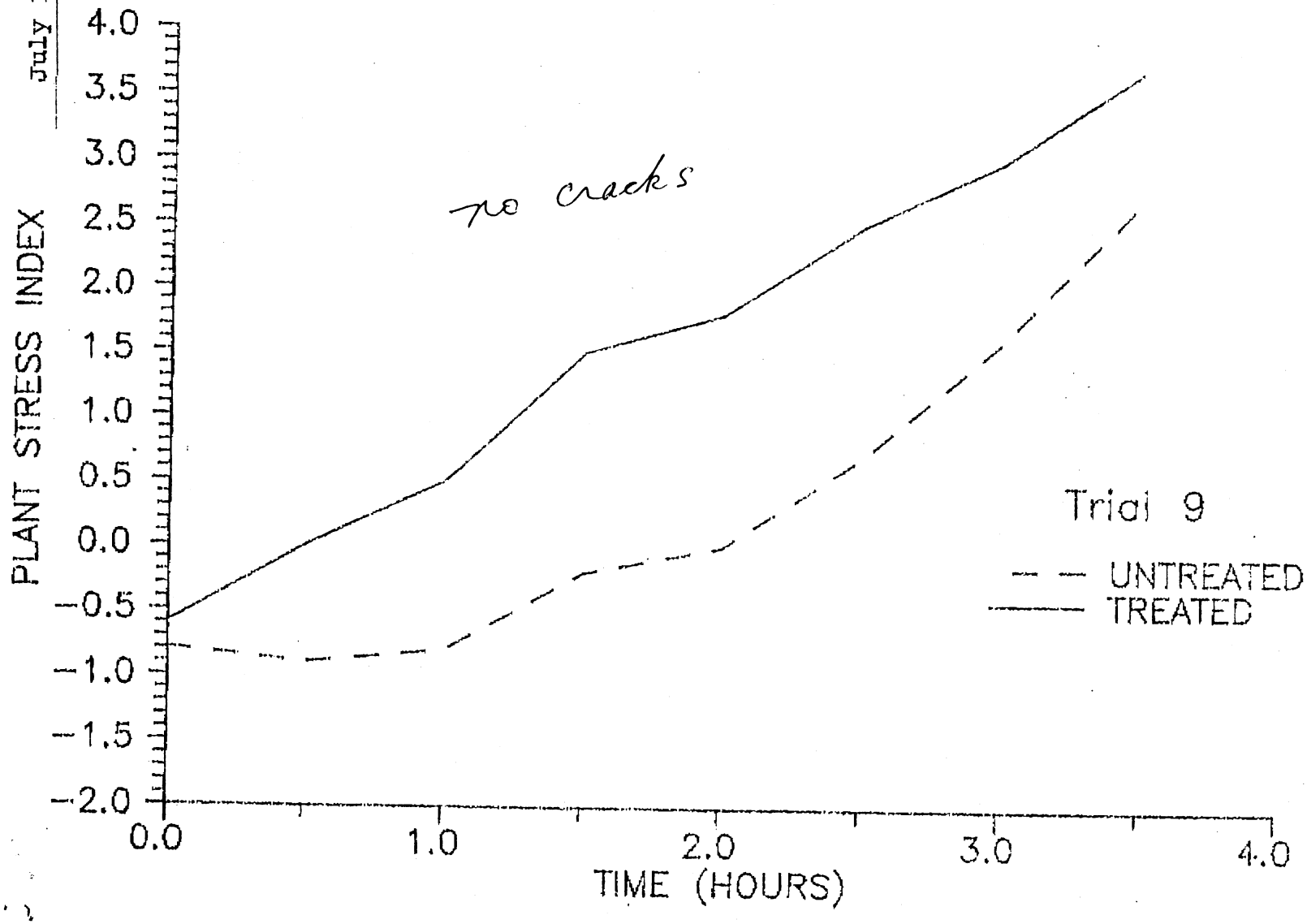
PLANT STRESS INDEX VS. TIME